### BIOCHEMISTRY - DOCTOR OF PHILOSOPHY (PHD)

The Department of Chemistry and Biochemistry is internationally recognized for its research and education. As part of a commitment to continuing this tradition of excellence, the department provides a graduate program that integrates opportunities for cutting-edge creative research and study across a wide range of areas, including analytical, atmospheric, biochemistry, biophysical, chemical physics, environmental, organic, materials and nanoscience, and physical chemistry.

Graduate students enjoy extensive scientific collaboration with chemistry and biochemistry faculty, with other departments, such as physics and molecular, cellular and developmental biology; and with research institutes and agencies, such as the Cooperative Institute for Research in Environmental Sciences (CIRES), Joint Institutes of Laboratory Astrophysics (JILA) and the National Oceanic and Atmospheric Administration (NOAA).

The Biochemistry Division offers a world-class interdisciplinary research environment in a beautiful mountain setting. Established in 1986, the Biochemistry Division spans a wide range of fields, from bioinformatics and cellular and molecular biology to synthetic and biophysical chemistry. Current areas of focus involve:

- Nucleic acid chemistry and biochemistry, including RNA structure and function and mechanisms of transcription and replication
- Structural biology, including X-ray and NMR, proteomics and informatics
- Molecular biophysics and signal transduction
- Proteomics, genomics and bio-informatics

### Requirements

#### Course Requirements

**General Requirements**

Sixty credit hours of course work is required, consisting of 30 hours of research in CHEM 6991, at least 15 hours in formal courses (see next section), and the remainder in other courses, such as summer courses, seminar courses, group meeting courses and research in CHEM 6901. All students are required to take a 1-credit course in Scientific Ethics and Responsible Conduct in Research (CHEM 5776).

A minimum grade of B- is required in all courses counting for the PhD degree; students should also be aware that they must maintain a cumulative grade point average of 3.0 in all formal courses and an overall grade point average of 3.0 or they will be placed on academic probation. Students may also be placed on probation if they are not making satisfactory progress in their research. Probationary status must be removed within two semesters or a student will become ineligible to receive a PhD degree from the Department of Chemistry and Biochemistry. Students on probation will not have a high priority for financial support.

A degree plan of courses taken and yet to be taken must be filed with the Graduate School by the end of the student’s third semester.

**Selection of Formal Courses**

All students are required to take a minimum of 15 credit hours of formal courses. Formal courses are regularly scheduled, examined and graded; courses such as summer courses, seminar courses, group meeting courses and research in CHEM 6901 are not considered formal courses. Each student’s program plan for course work must be approved by the student’s research advisor and the Biochemistry Graduate Committee. These formal courses must be approved prior to the end of the fourth semester, and students are encouraged to complete formal course requirements within their first four semesters. The Biochemistry Division recognizes that some formal courses of interest are only offered every two years, and the Biochemistry Graduate Committee takes this into account.

#### Transfer of Credit

Up to 10 credits of graduate-level, formal course work may be transferred from another higher education institution, subject to demonstrated proficiency in the subject(s) and written approval by the Biochemistry Graduate Committee. Students can obtain forms for this purpose from the Graduate Program Administrator.

**Formal Application of Admission for Candidacy for the Biochemistry PhD Degree**

All students must submit a formal application for admission to candidacy for the PhD degree before they take their Comprehensive Oral Examination. Students can obtain the appropriate form from the Graduate Program Administrator. This Graduate School requirement should be fulfilled even though students have not yet completed all their formal course work. After filing in the form, indicating graduate courses taken and to be taken, it should be approved and signed by the student’s research advisor and then the Biochemistry Graduate Committee. A completed form needs to be in the student’s file before they can take the Comprehensive Oral Examination.

PhD students shall have passed their Written Cumulative Exam and the Comprehensive Oral Examination before being admitted to candidacy for the PhD degree. Students should note that the approved research proposal must be filed in order for a student to be advanced to candidacy.

### Research Requirements

During the course of the PhD thesis work, students will arrange annual meetings with a thesis advisory committee composed of their research advisor and two other biochemistry faculty. The purpose of these advisory meetings is to ensure the student is making adequate progress on a suitable PhD thesis project. The final annual meeting should be scheduled about one year from the end of the thesis work. For this meeting, the advisory committee will be expanded to five faculty members: the thesis advisor, three biochemistry faculty and one faculty member from another department. This committee will become the examination committee that evaluates the results of a completed research program submitted as a thesis for the final examination as described above.

#### Examination Requirements

Each PhD student is required to satisfy a preliminary examination and pass a series of Comprehensive Examinations to be advanced to candidacy. The candidate must then pass a final thesis defense examination to be awarded the PhD degree. Interdisciplinary students should adhere to specific program requirements.

**Preliminary Examinations**

The Graduate School requires that the department administer preliminary examinations in order to "satisfy itself (by examination or other means) that students who signify intent to undertake the PhD degree are qualified to do so." The Biochemistry Division preliminary examination will be conducted at the end of the student’s second semester by a
committee of three or more members of the division. The record of each student, including undergraduate preparation, performance in graduate course work, TA performance and performance in laboratory rotations will be reviewed, and a recommendation will be made on the qualification of the student to continue in the PhD program. Outcomes may include recommendation for additional course work, delay in joining a research lab or a recommendation to leave the program. Students who are considering interdivisional work should consult the Biochemistry Graduate Committee for advice on the preliminary examination requirement.

Language Requirements
The Graduate School rules state that "a student who is noticeably deficient in the written and/or oral use of the English language cannot obtain an advanced degree from the University of Colorado at Boulder." The department assesses the English language proficiency of each PhD student in the Comprehensive Oral Examination.

The department does not require proficiency in a foreign language for the PhD degree.

Comprehensive Examinations
The Comprehensive Examinations are made up of three parts: a Written Examination, an Oral Examination and the evaluation of an original research proposal. The oral examination and the research proposition evaluation shall be conducted by a five member examining board, according to the rules of the Graduate School. One member of this board shall be the student’s research advisor. The membership of this board shall be selected by the Biochemistry Graduate Committee, in consultation with other faculty members as necessary. The Comprehensive Examinations are considered passed when the requirements of all parts have been met.

Written Comprehensive Examination
All biochemistry PhD students will take a Written Comprehensive Examination at the end of their first year. If a student fails the exam, they may be encouraged to take classes in fall semester of their second year to help make up for deficiencies, and they must take the written exam again. The student can still take their Comprehensive Oral Exam, but they will not be able to advance to candidacy until they pass the Written Exam. The Written Comprehensive Examination will remain in the student’s folder, and will be available to the orals committee to help them determine whether the student is capable of PhD work.

The Written Comprehensive Examination for the biochemistry PhD will be written and graded by a selection of faculty within the department. The Biochemistry Graduate Committee is responsible for the overall administration of the process, and will certify that each PhD candidate has satisfied the examination requirements as stated above.

Comprehensive Oral Examination
Students must take the Comprehensive Oral Examination no later than the end of the fourth semester. This examination will include questioning on two topics: the student’s research and general topics. Students are expected to demonstrate a clear understanding of their thesis research and fundamental knowledge in biochemistry, and show the ability to think creatively. Students are strongly advised to spend time reviewing material from chemistry and biochemistry courses they have taken as undergraduates and graduates, since this material is often the subject of questioning during the examination.

The Oral Examination committee consists of three of the five faculty members appointed to the examining board selected by the Biochemistry Graduate Committee. The student’s research advisor, while a member of the examining board, may not be a member of this committee. Students are responsible for arranging the examination date with their committee and should notify the graduate secretary two weeks prior to the scheduled date. At least one week before the exam date, students will present a short written overview (5 single-spaced pages) of their thesis research plan to each committee member. This overview will outline clearly the direction of the student’s thesis, provide the committee with advance notice of the thesis research area, and will describe promising research results (if any).

The decision of the oral examining board shall be determined by a simple majority of the members. The committee shall determine whether the student is capable of PhD degree work or not. The possible outcomes of the examination are:

PASS: The student’s performance on the examination was PhD caliber.
INCOMPLETE: The student’s performance was PhD caliber in some areas, but was below what is expected for a PhD student in other important areas. In this case, the committee will give the student a set of specific requirements to fulfill and will reconvene in no more than three months to complete the examination. If the examination is not completed within the three-month period, it is considered a fail.
FAIL: The student’s performance on the examination was not PhD caliber. By Graduate School rules, a student has the option of requesting a second attempt of this examination. This request should be made to the Biochemistry Graduate Committee. Before the student can take a second exam, the committee may require that the student completes class work to remediate deficiencies and/or completes a research master’s degree. If the request for a second examination is granted, it will occur no later than a year from the first exam, but the committee may set an earlier date. For the second examination, the oral committee is expanded to five faculty, with at least two from the first examination. The result of this examination will be limited to pass or fail. If a student doesn’t take this second examination by the date specified by the committee, they will not be able to continue in the PhD program.

Out-of-Field Research Proposal
Each graduate student in the department is required to write an out-of-field research proposal. Biochemistry students write and defend such a proposal in Advanced General Biochemistry 2 (CHEM 5781) (spring semester "core"). Biochemistry students should make note of critiques of the proposal, rewrite it and hand it in to the CORE instructor for final approval. The final copy of the approved proposal needs to be in the student’s file before they can take the Written Comprehensive Examination.

Upon satisfactory completion of all three examination requirements, the five members of the examination board shall recommend the student for advancement to candidacy for the PhD degree.

Final Examination
This examination is primarily a defense of the candidate’s thesis. The examining committee consists of the student’s thesis advisor as chair, and four other faculty members, at least one of whom is rostered outside of the department. These committee members are selected by the Biochemistry Graduate Committee upon request and after consultation with the student. The student must arrange for one of these other committee members to be the “second reader” of the thesis. The second reader will carefully review the thesis with the candidate. The student is responsible for arranging the date of the examination and notifying the Graduate Program Administrator at least two weeks prior to the date, and is responsible for distributing copies of the dissertation to the committee.
members — after it has been approved by the thesis advisor — at least two weeks before the examination. Failure to meet this latter deadline is a legitimate reason for any thesis committee member to postpone the examination.

**Time Limit**

Students should note the time limit specified in the Graduate School rules: “All doctoral students are expected to complete all degree requirements within six years from the date of the start of course work in the program.” Information on extensions is available in the Doctoral Degree Requirements (catalog.colorado.edu/graduate/degree-requirements/doctoral-degree-requirements/#timelimittext) section.

**Petitions**

With the approval of the thesis advisor, students may petition for exceptions to the above mentioned rules due to special circumstances. The petition should be addressed to the Biochemistry Graduate Committee, which may consult with other faculty before responding to the petition.